THE AERONAUTICAL JOURNAL.

OCTOBER, 1899.

The Aeronautical Journal.

(PUBLISHED QUARTERLY.)

SUBSCRIPTION PER ANNUM (post free), 4s.

Communications respecting Advertisements to be addressed to the Publishers, "Aeronautical Journal,"

Messrs. KING, SELL, & RAILTON, Ltd., 4, Bolt Court, 12, Gough Square, and 4, Birchin Lane, E.C.

NOTICES OF The Aeronautical Society.

A Meeting of the Council was held on September 12th. The following gentlemen were elected Members:—

Sr. MIGUEL G. FLORES, Spain.
Capt. T. S. H. WADE, Lanc. Fus.
Lt. H. OSBORNE MANCE, R.E.

The following gentleman was proposed as Honorary Member:—

Mr. F. H. WENHAM.

The following additions to the Rules of the Society were duly passed:—

ADD TO RULE IV.—"Any member who has not paid his subscription for two consecutive years, notice having been sent to him during each year that such was due, shall be liable to have his name removed from the list of members."

NEW RULE VIA.—"In order to meet the wishes of those who desire to be connected with the Society, but who do not care to become ordinary members, certain persons may be admitted, by ballot, as Associates. Their subscription to be five shillings per annum. They will be entitled to attend all meetings of the Society, of which due notice will be sent to them, but will not be entitled to other privileges of membership."

B. BADEN-POWELL, MAJOR,
Hon. Sec.

Meeting of the Aeronautical Society.

A meeting of this Society was held on Friday evening, the 26th July, at the Society of Arts, John St., Adelphi, under the presidency of Mr. E. P. Frost. Several papers were read, and a number of working models exhibited.

(The full text of these papers not having yet been sent in, must be printed separately.)

DR. BARTON, on being called upon to read his paper, on "a new navigable balloon," alluded to the pleasure it gave him to be elected a member of the Society, and hoped to be able to do his share to advance the science, for the advancement of which the Society was founded. During the reading of his paper, Dr. Barton made frequent reference to the aeroplane frame, a large model of which was suspended before the platform. The general idea of the invention is an elongated balloon propelled by a screw in the car, and having below it a large aeroplane, the inclination of which can be altered at will, so as to cause the balloon to ascend or descend as required. Dr. Barton read several accounts from different newspapers, describing the experiments he had made with his model machine, which was propelled by clockwork. The first experiment took place on March 10th. He had wished to ascertain what the machine would do in still air, so he had it taken to the Town Hall, Beckenham, and had tried it there, in order that it might be uninfluenced by any currents of air. On that occasion when the aeroplane had been put level, and the rudder placed at the correct angle, the machine had turned round and round continuously, which spoke well for the efficiency of the rudder in still air, as the

space in the Beckenham Town Hall was very limited. The next experiment was on the 16th March out in the open. It was a very unfavourable day for the experiment, and although on the whole it had proved satisfactory, considering the gustiness of the day, the experiment had not been completely successful. On that occasion, said Dr. Barton, he had not mastered the arrangements of the rudder, and something went wrong with the propelling machinery, which was very weak. The report appeared in the Daily Chronicle of the 17th March.

The next experiment was on the 8th May, and was a very much more successful one. On that occasion, Dr. Barton wound up the clockwork to the full, and the machine travelled 4 miles in about 23 minutes. He had made a hole in the aerostat before starting it off, otherwise it might have gone for a longer distance. It went straight forward until the clockwork stopped and then—and this Dr. Barton considered a very important point—the machine went round and round like any ordinary balloon.

Another trial took place on 26th May in the open, but since then, Dr. Barton had been too busy to make any further trials. He produced several photographs of the machine in mid-air, but explained that they were not good owing to the great difficulty of photographing such an apparatus in rapid motion across the sky.

Mr. Pollock criticised the model as having no outlet for the gas to escape if it ascended to a great height. Mr. Davidson asked what was the greatest speed actually obtained with the model.

Dr. Barton replied that he did not think the actual speed was more than 2 miles an hour, but then the clockwork weighs only 4 lbs., and the propeller is about 1 foot across. He was now getting a new clockwork motor made of about 10 or 12 lbs., which would be much more powerful.

Mr. Pierce said, as one who had watched this matter from its initial stage, that he had witnessed several successful experiments, and firmly believed that we are landed at least one step nearer the desired haven.

Mr. Reid remarked with reference to the use of gutta percha for the balloon, that this substance is apt to rot from the absorption by the gutta percha of the hydro-carbons present in the gas. That was a point which he (Mr. Reid) had experimented upon when he invented the material known as "Velvril," which material Dr. Barton had referred to in his paper. This material does not absorb those hydro-carbons present in the gas. Mr. Reid added, "I think we are very much indebted to Dr. Barton for giving us the result of his experiments. It is practical experiment we want, and not discussion (Hear, hear). I do not know whether Dr. Barton has found any difficulty in the collapsing of the front part of his balloon in driving it through the air, but if so, it would be quite possible to obviate that by placing the propeller in front. I believe that has been tried successfully in France. If you place your propeller in front, instead of pushing your balloon, you drag it through the air currents, and in that case the tendency for the front part of the balloon to collapse is not nearly so great." (Applause.)

Dr. Barton said he was very pleased to have met the inventor of this material—"Velvril," and hoped to make many more experiments with it. As to collapsing, he thought that with a larger machine, it might be necessary to have an aluminium casing over the front part of the balloon. It would not weigh very much, and it would be perfectly rigid, and would prevent the air forcing the apex in.

The next paper was read by Mr. D. M. B. Smyth, on a new form of aerial propeller. In this, he explained the blades were normally plane surfaces without pitch. But on rotating, a pitch was automatically created. Mr. Smyth then exhibited some models, in which the propellers were rotated by twisted india-rubber, after the fashion of the well-known toy butterflies.

The third paper was by Mr. Cochrane, who exhibited a well constructed little model with a brass compressed-air engine, the pistons of which acted on 4 reciprocating wings, each consisting of a number of blades. These blades were so arranged as to have a valvular action, opening during the up-stroke to let the air pass and closing to form a powerful wing on the down stroke. The power given by the engine, however, Mr. Cochrane explained, was not so great as he could desire, and though the wings beat rapidly, the apparatus was not able to rise in the air.

The Chairman then called upon Mr. Davidson, who, he said, had some models to show the Meeting.

Mr. Davidson (who was received with applause) said he had had no intention of showing anything that evening, but having completed the small model they now saw, he thought it might interest the members if he brought it down. (Hear, hear.) He did not intend to work his model on that occasion, as it was necessary to have "live" air, and also

that the machine should be dropped down in order to get "way" on it before it could be started. One thing was most important if they were going to travel through the air, and that was that they must keep their equilibrium. If they were going to make any machine, they must be sure that that machine would remain vertical. He had been studying that point, and in the model he then produced, he had a means by which a body gliding through the air would absolutely maintain its equilibrium. He maintained that that model was the first mechanical contrivance that had ever yet been made that would automatically keep its equilibrium—or its horizontal stability—in gliding through the air. Professor Langley had a means of keeping his machine horizontal, but in that case it had been propelled exactly like a ship in the water, and not like a bird. Mr. Davidson did not explain the mechanism of his invention, in which the tail was apparently acted on by a pendulum inside the structure, which, in the event of the machine losing its equilibrium in one direction, immediately caused it to be recovered in the other. Mr. Davidson stated he intended to make experiments with models of 3 ft., 6 ft., 12 ft., and 24 ft., and in that way he hoped to obtain very valuable data.

Mr. Moy remarked that pendulums have been patented over and over again for that very purpose.

The Chairman.—It is extremely gratifying to find that so many persons are hard at work on this most interesting subject. Personally, I have not had a great deal of study in balloons, but I have in navigating the air by mechanical means. We are led to believe by Dr. Barton that his experiments have been successful, and there is nothing that succeeds like success. He speaks of "buoyancy," that is to say, I suppose he means that his machine will be equal in weight to the weight of air in which it sails, but I fear it would be more or less at the mercy of the winds under those conditions. I trust that that little piece of mechanism of which he has told us may lead him to success. With reference to Mr. Smyth's new theory of horizontal flying, I am inclined to think that gravitation is an agent in favour of natural flying, although Mr. Smyth seems to overthrow that idea. If I understand him rightly, he overthrows the force of gravitation by a force that he creates in his machine. Perhaps the form of the leading feathers in a bird's wing, acting upon the force of gravity, tends to send the bird on. I am sure we are all extremely obliged to the gentlemen who have given us these papers this evening. What Mr. Davidson has said has been extremely interesting. I can quite understand that his model would not act unless it had an eight or a ten foot fall. He is not able to show us the peculiarity of the mechanism, but he has told us that it works automatically, and can preserve its "horizontal stability." I should like to say again that I am sure we are all very much obliged to each of the gentlemen who have given us the benefit of their papers this evening. (Applause.)

Mr. Davidson proposed a vote of thanks to the Chairman, and with his, coupled the name of our very energetic Secretary, Captain Baden-Powell. (Applause.)

The Meeting then closed.

The Zeppelin Air-Ship.

What is without doubt one of the most important attempts to solve the problem of the navigation of the air is now being made on the shores of the Bodenzee, in Wurtemberg. The general idea is that of what has hitherto been called a dirigible balloon, but this term hardly describes the huge ship with its metal framework and outer cover containing a number of balloons. It is nothing more or less than an aerial steamship.

The inventor is Count Zeppelin, a Lieutenant-General in the German Army, whose name was well known at the time of the Franco-Prussian War, for the daring reconniassances which he carried out. Before that, he had attended, in a private capacity, the civil war in America, and his first balloon ascent was in one of the military balloons of the Federal Army. More recently he has been employed on the staff of the king of Wurtemberg, and in this capacity has attended several state functions in England. The count has for many years been interested in the study of aerial navigation, and is said to have spent something like £25,000 on his experiments. Then, with several very influential supporters, he formed a company with a capital of one million marks (£50,000), and started on his present venture. A commission was appointed to enquire into his plans, and report on the probabilities of success or otherwise. When asked whom of notable scientific men he would like appointed, he replied "Prof. Helmholtz, because he is the greatest opponent of my theories." The Professor was appointed, went deeply into the subject, and finally owned that the matter was well worth trial.

The general principle is to construct a very long balloon—the length giving the requisite buoyancy without increase of resistance by sectional area. This principle appears to be sound enough, since we know that ships have sometimes been cut in half, and an extra length added without the speed of the ship being thereby diminished. But such great length necessarily involves a framework to keep the balloon rigid. This framework consists of a number of large hoops with longitudinal pieces connecting them and diagonal wire stays to impart rigidity. So far, the idea is very much the same as that so ably brought forward by Mansfield in his book on "Aerial Navigation." But times have changed, and the materials used are such as even Mansfield had scarcely thought of. The framework is almost entirely constructed of aluminium, lattice-girders about 7 ins. wide being formed of bars, the whole riveted together with aluminium rivets. This enormous structure, somewhat resembling a vast bird cage, looking as frail as a cob-web, yet really of marvellous strength and stiffness, weighs about 7,260 lbs.

Over all this framework is stretched hempen netting, both to the inside and outside of the girders, so that there are two layers of netting, as there are to be two skins to the balloon. This immense framework, over 420 ft. in length, is subdivided by network partitions, in each of which a gas bag of corresponding shape is inserted, so that altogether there will be something like 17 balloons. Outside all will be a cover of water-proofed silk, both to make a smooth surface for the air and to protect the balloon, and the space between the two will tend to mitigate the varying influences of temperature on the gas.

The ends of the cylinder, which is nearly 37 ft. in diameter, are of an ogivale shape—that is, similar to the bow of a boat, or head of a projectile—the point being formed of a nearly hemispherical aluminium cap.

Under almost the entire length of the vessel runs a gangway or gallery, a couple of feet wide, of aluminium plate. This adds rigidity to the hull as well as forming a means of communication. The two cars are also made of aluminium plate, looking like water tanks, and are rigidly connected to the main framework.

Not the least interesting feature of the construction is the method of housing this aerial monster. A huge raft has been made nearly 500 ft. long, on which a great wooden house has been built. At one end is an immense doorway with canvas curtains to close over it, which consequently has very much the appearance of the proscenium of a theatre. This structure alone is said to have cost £10,000. The advantages of such a floating stable are many. First, if it had been built rigidly on shore, and it were required to draw out the balloon (not unlike drawing an enormous sword from its scabbard), it can well be understood that, should the wind be blowing strongly against the door, or on one side of the house, there would be great difficulty in doing so. By mooring the raft, however, at the bow only, it naturally swings away, so that the doorway is always to leeward, and the airship can be drawn out with the wind. Then an open space of water all round, without trees or buildings to interfere is most desirable in starting the machine, and in the event of an accidental precipitation, no very serious damage is likely to come to either men or machine. Add to these the economy of not having to buy or hire land, no risk of damaging crops, and comparative ease of keeping inquisitive sightseers at a respectful distance, and the great advantages of the system may be realized.

There is, moreover, another device to aid the task of starting the balloon. The great house-boat is in reality a floating dock, containing within it a long raft, on which the balloon rests. When the start is to be made, this raft is towed out of the house, and there is the balloon all ready for ascent.

But this great floating structure is not the only accommodation provided for the undertaking. Near by is a floating shed containing a number of pontoons to carry the gas tubes for inflation. Then there is the boat-house to accommodate several oil-launches and other boats, while on shore some great sheds are erected, wherein the balloons are prepared and varnished, and the usual offices and draughtmen's rooms complete the establishment. The whole affair is thus undertaken in no small way. Four engineers are employed to carry out the inventor's designs, and from 40 to 70 artisans are usually at work under their orders. It is a veritable dockyard, which one can hardly realize is solely established for the coming ships of the air.

Then as regards the propulsion, another novelty comes in. Count Zeppelin is convinced from the experiments he has made, that small screws revolving at a high velocity are more efficient than those which are large, and rotated at a slower rate. The line of propulsive power should evidently be as near as possible coincident with the centre of resist-

ance, and therefore, instead of placing the propellers underneath the balloon, as has so often been done in former attempts, he places them at each side of the vessel on a level with the central axis. Two pairs of propellers, each being a four-bladed screw, about 3 ft. 6 ins. diameter, are thus arranged, one pair near the fore part and one near the after part of the ship. Two cars, to carry the engines are placed below, each containing a benzine Daimler motor of about 15-horse power. These engines are connected to the screws by bevel gearing and aluminium tube shafts. In order to avoid any danger of firing the balloon, as occurred to Dr. Woelfert some years ago, the ignition of the engines is electrical, and the exhaust pipes are carefully closed in with double wire gauze.

The question of propulsion is the gist of the whole matter. It may be laid down as an axiom that a navigable balloon to be a practical success *must* be able to attain a speed of at least 20 miles an hour. Anything much less than this would be insufficient to stem a moderate breeze, and if so huge a vessel is wafted away from its dock, it would be most difficult to house elsewhere, and would run a great chance of being wrecked by the wind. The inventor is very hopeful of being able to attain a speed of at least 22 miles an hour, and this seems not improbable on considering theoretically the data.

The count has been testing his propellers in a very practical way. He has rigged a framework on a large boat in which the engine is placed, and the screws being fixed in position above and geared to the engine just as they would be in the balloon, but with shorter connections. On revolving the screws (at 1,100 revolutions per minute), the boat is driven along through the water, and has thus attained a speed of 12 miles an hour. By taking into consideration the relative densities of the resisting mediums and the surface of resistance, a very good comparison can be made, from which the inventor obtains his calculation of 22 miles an hour.

If we further consider the matter by taking other data, we get equally encouraging results. Thus, on comparing this with the most practicable navigable balloon we have hitherto had, viz. "La France," we find that the latter with about 8-horse power, attained a speed of 14 miles per hour at its best. Its sectional area was about 520 sq. ft., or a little more than half that of Count Zeppelin's vessel. Roughly speaking then, we may say that we have four times the engine power to drive double the resistance, which, other things being equal, should give half as much speed again, or 21 miles an hour.

Other tests may also be put. For instance, the formula given by Dr. Pole and de'Lome

$$v^3 = \frac{385\,r}{S\,X}\,(A\,d - B)\,d\,l$$

works out the velocity at 38 ft. per sec., or 26 miles per hour.

Or, again, the propulsive effort to drive such a vessel through the air at the rate of 22 miles an hour should be about 120 lbs. Maxim obtained a thrust of 2,000 lbs. with his 360 horse-power engines, which in proportion should give also 26 miles per hour. Davidson and Walker with a propeller very little larger and with a slightly higher rate of revolution, obtained a thrust of 40 lbs., which multiplied by 4 would give 160 lbs. So that all points to the probability of a sufficient speed being attained.

It will be useful to consider for a moment the effect of head winds on a machine capable of going 22 miles an hour. As far as daily *mean* velocity of the wind goes, only on an average of about one day in a week is it greater than this in England, though the *maximum* pressure of occasional gusts might often imply a greater rate. Then it would, of course, be impossible to go to windward at all. Still even this does not nullify the usefulness of the vessel. Mornings and evenings are usually comparatively calm, and plenty of opportunity is thus given for *experiment* or for short trips. When carrying out long journeys, the great question will be how to house the huge vessel when a strong contrary wind does come on to blow.

Landing will also be a very ticklish manœuvre, as anything like a bump might cause the whole framework, and especially the propeller connections, to be bent.

As for steering the craft, two vertical rudders are provided for changing the horizontal direction of progress, while the vertical course and the general level of the vessel is regulated by a shiftable weight to be drawn, by means of ropes, towards one or other end of the ship. This latter arrangement may appear somewhat clumsy, and if the vessel, as a whole, proves successful, we predict that some other contrivance will be adopted for regulating the horizontality.

With the idea of being able to ascend to a considerable height in the air, the balloons are, in filling, not to be fully distended, so as to allow for expansion in rarefied regions; but smaller auxiliary gas bags are sandwiched in between, fitted with valves, so that they can

be emptied of gas as desired, while the main balloons remain with their charge of gas intact.

It is still a matter of some doubt as to when the machine will be ready to make its initial trials. Delays have been frequent, and it was expected that it would have been ready before this. But all is now very nearly complete. The framework is practically finished. The balloons, made by a professional aeronaut, are delivered. The engines and propellers are in working order. All that is needed is to place them all together, and inflate the balloons. This is to be done by means of 2,600 tubes of compressed gas, which are to be floated out in large pontoons, and connected by pipes with the balloons. Of course, for such an experiment as the first ascent, it will be necessary to await for the most favourable weather, as without doubt many trials will be necessary before the craft is in a really workable condition.

When the ascent is to be made, the count hopes to command his vessel with two engineers in each car. These men have each been going through a course of ballooning to accustom themselves to their new calling.

With only five men there will be a large margin of buoyancy left for ballast, perhaps 3,000 or 4,000 lbs., which should enable a long journey to be performed.

We reproduce here an illustration of the floating house, also a rough diagram from the patent specification, but hope in our next number to be able to give a series of photographs of the machine.

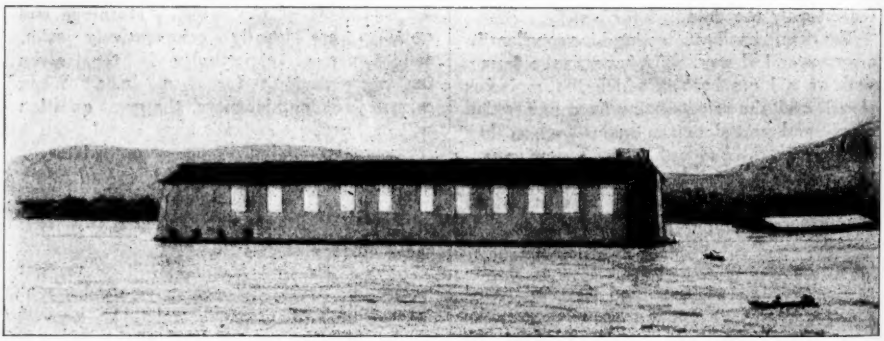
Long-Distance Ballooning.

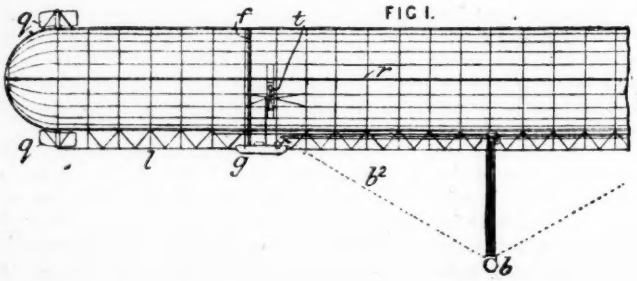
LIEUT. H. OSBORNE MANCE, R.E.

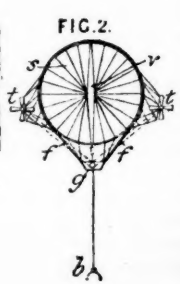
[From the *Field*.]

A report has been going the rounds of the press abroad to the effect that a party of German aeronauts contemplate making an experimental long-distance balloon trip, starting from Germany and travelling in an easterly direction, the object of the voyage being to discover experimentally how long a balloon may remain in the air before coming to the ground.

Whether there is any foundation for this report or not, there can be no doubt that experiments of this kind are necessary for the advancement of the science of aeronautics. Long-distance ballooning has been hitherto neglected, as far as practical trials are concerned. A few long voyages may have been made, but the ill-fated Andrée appears to have







been the first to devote systematic attention to this special problem, in connection with his attempted voyage to the North Pole. As a general rule, the art of ballooning has for the last few decades been utilised for either public ascents of comparatively short duration, made by professional aeronauts, accompanied perhaps by one or more enterprising passengers desirous of experiencing the sensation of ballooning, or for the purpose of scientific investigation of the higher strata of the atmosphere, and very little has been done to promote the science of ballooning itself. Possibly this is to be accounted for by the expense inseparable from experiments of this nature, involving, as they often do, the use of special apparatus, the design of which can only be satisfactorily accomplished after much thought and many fruitless trials.

Up to the present day the voyage of longest duration is that of Andrée, who had just been forty-eight hours in the balloon when he despatched his pigeon message. The next longest are thirty-six hours in 1892 by M. Mallet, twenty-four and a half hours by M. Hervé in 1886, and twenty-four and a quarter hours accomplished by the great Leipzig balloon in 1897 with eight people in the car. The distance covered on this latter occasion was 1032 miles, probably the longest balloon journey on record.

As regards speed, short journeys of under two hours have been done at ninety and eighty-eight miles per hour, and the Channel has been crossed at a rate of seventy-seven miles per hour. In a recent voyage made by some German officers 420 miles were covered in six hours.

The idea of long-distance ballooning suggested itself to Andrée during a voyage across the Atlantic, when he was so impressed by the regularity of the trade winds that he contemplated a trans-Atlantic balloon trip. He was, however, forced to abandon the idea, as he felt that funds would not be forthcoming for an expedition which would savour to most people of absolutely useless foolhardiness. When his expedition to the North Pole was decided on he was recommended to make some overland experiments on a large scale to verify the theories on which he was about to stake his life, but this advice was not taken, probably for the same reason—lack of funds. However, Andrée cannot be said to have started on his famous voyage without having previously put his apparatus to the test, as several successful journeys were made by him and by his colleagues across the Baltic and in the Mediterranean.

Long-distance ballooning may be divided into two classes of journeys; those in which the destination is immaterial, and those in which it is intended to reach some pre-determined goal. To succeed in the first case, assuming favourable weather, requires the solution of only one problem, that is—to keep the balloon in the air as long as possible. In the second case it is, in addition, necessary that the balloon should be steerable to a certain extent.

The short duration of ordinary balloon voyages can be accounted for by the following principal causes. Firstly, the small size of the balloons used; secondly, the leakage of gas through the open neck, and through the envelope of the balloon; and thirdly, the impossibility of getting an absolutely free balloon into a state of stable equilibrium at a uniform height in the air, and the consequent necessity of constantly throwing out ballast to compensate for the gas lost by successive rising and falling of the balloon. It is obvious that other things being equal, the larger the balloon the more ballast and gas can be lost before the buoyancy is exhausted, and it is universally admitted that for long journeys a large balloon is necessary. Andrée's balloon had a capacity of 162,000 cubic feet, and the balloon to be used in the projected German trip is still larger, having a capacity of 42,380 cubic feet more, or a total of 204,380 cubic feet, and a lifting power of 120 cwt., besides the weight of the balloon and car.

As regards the leakage of gas, it is absolutely necessary to have an outlet for the gas to avoid all danger of bursting the balloon, owing to the pressure caused by the gas being expanded or by a diminution of external pressure, but there is no necessity for an outlet of 12 to 18-in. diameter permanently open and permitting the diffusion of the gas from the interior and the entrance of air from the outside. An obvious remedy is to have at the neck a valve opening only to let out gas at a certain pressure, far less than that which would cause any dangerous strain to be imposed on the envelope of the balloon, but which would prevent any loss of gas due to minor variations of temperature and pressure, and would also preserve the gas to a large extent from an admixture of air. Andrée used a valve of this description designed to open at a pressure of 10 millimetres = 4 in. of water. Much leakage is also prevented by an efficient top valve. This valve may be either of the ordinary or of the rending pattern. The latter is practically gas-tight, but limits the control of the balloon, and once opened cannot be

closed again. This pattern was used in the recent cross-Channel trip by the *Times* and *Daily Chronicle* balloon.

The leakage through the envelope, though negligeable in the ordinary balloons used for free ascents, compared with the losses due to other causes, is a serious consideration in balloons designed for long journeys, or to be used as captive balloons—another case where it is desired to maintain the buoyancy as long as possible. This question has been carefully investigated by all military ballooning establishments, to whom it is of great importance that the expenditure of gas should be a minimum on active service, and formed one of the principal difficulties Andrée had to contend with.

It is beyond the scope of this article to enter into details of the means employed to reduce this leakage to a minimum, but as examples of the results obtained, it may be mentioned that Andrée's balloon was said to leak only 1 cubic foot per diem; English war balloons, made of skin, leak 3 per cent. in twenty-four hours; and French balloons, made of fine pongee silk coated with varnish, lose 4 per cent. in the same time. The balloon which is said to be the one selected for the proposed German expedition is that which did duty as a captive balloon at the Berlin Industrial Exhibition, so that the amount of leakage to be expected should be accurately known from the consumption of gas required to maintain its buoyancy, due allowance being made for the different rate of diffusion of hydrogen gas if coal gas was used in the first case. Should the leakage be unsatisfactorily large, steps will no doubt be taken to render the envelope more gas-tight.

It has been suggested that cylinders of compressed hydrogen should be taken instead of ballast, as these could be used to replenish the gas, and the empty cylinders as discardable weight. Neglecting the possible inconvenience resulting from a rain of cylinders from on high, and their unsuitability in other respects as ballast, the amount of gas which could be taken up in this way would be extremely small. For instance, the French cylinders used for carrying gas in the field for military balloons weigh 1000 lbs., and only carry 1400 cubic feet of gas at 3000 lbs. per square inch pressure. English cylinders weigh 95 lbs., and carry 150 cubic feet of gas at a pressure of 1950 lbs. per square inch.

It is evident from the above remarks that the chances of achieving a record are greatest if the journey is made in a climate and season where the atmospheric changes are neither great nor frequent. It has been recommended that in hot climates the top of the balloon should be screened from the sun by a light awning, but this would not appear to be effective except in equatorial latitudes.

Up to the present there has been no satisfactory method devised whereby a perfectly free balloon can be made to remain for any length of time at a constant altitude without a prodigal expenditure of gas and ballast far in excess of that due to the gradual leakage of gas. Could this be effected in the case of a large gas-tight balloon, and the loss of ballast be consequently reduced to that necessary to compensate for the gradual leakage of gas through the envelope, a free balloon could be maintained in the air for a time limited only by the desire and the purse of the aeronaut. But, although this condition has not yet been attained in the case of a perfectly free balloon, there is no doubt that the addition of a suitable trail rope, the end of which is allowed to drag along the ground, affords a very fair solution of the difficulty. This trail rope, the use of which has been known for many years, acts as a species of automatic governor, any tendency of the balloon to rise being counteracted by the gradually increasing weight of rope carried by the balloon; while, if the balloon commences to descend, it is relieved of the weight of the additional length of rope allowed to trail along the ground, a position of equilibrium being automatically arrived at in each case. After the height of the balloon has been once adjusted, the only discharge of ballast necessary will be that due to leakage of gas, and the full importance of having a gas-tight envelope becomes at once evident.

It has not been generally recognised that a great deal depends on the size (both length and thickness) and the material of the trail rope. The friction of a trail rope dragging over land or water retards the progress of the balloon to an extent depending on the quantity and nature of the rubbing or immersed surface of the rope and on the speed of the balloon. In consequence of this the trail rope, when there is any wind, will be at an angle to the vertical, and will lie in a catenary curve. Now it is fairly evident on the face of it, but can be verified quantitatively by mathematical investigation, that the thinner and shorter the trail rope, and the greater the resistance, the flatter will be the catenary, and the greater the chance of the balloon being blown down to the ground or sea. Also, the thinner the rope the greater the length which must be immersed to compensate for any given variation in buoyancy, and certainly the greater the resistance

for the same *weight* of rope immersed, and the more chance of entanglement with obstacles below.

Consequently, when a trail rope is employed to regulate the height of a balloon, it should be as long, heavy, and smooth as possible, always providing that for an over-sea journey the lower part of the rope at least is not heavier than water. The quantity of ballast taken is not thereby reduced, as the trail rope is as good as ballast, and can be eventually used as such if required. The partial failure of the *Times* and *Daily Chronicle* experiments during the cross-Channel trip made by their representatives was doubtless due to the use of too light a trail rope. Andrée had to have a certain weight of trail rope to counteract the varying buoyancy of his balloon at different temperatures. This weight he divided into three ropes of different lengths so as to make each rope more manageable, and both to divide the risk of entanglement and enable him to detach a portion of a rope if it caught in anything without materially lessening the efficiency of the trail ropes as a whole. The ropes were 1205 ft., 1042 ft., and 1017 ft. long, and weighed about 2204 lbs. in all. The lower portions were coir rope of specific gravity not greater than water. Statistics regarding rope friction on land and in water would be of value in this connection; the friction of a rope in water appears to be greater than that of the same rope on land. Andrée found it necessary to reduce the friction of his ropes as much as possible by impregnating them with vaseline. It is, of course, just possible that the friction of an ordinary rope is too great and retards the balloon to such an extent that it is blown down dangerously near the ground or sea. In this case some other material will have to be employed for the trail rope, perhaps leather.

There is at present a slight element of uncertainty as to the most advantageous materials and dimensions for a trail rope, but therein lies the more reason why experiments should be made to solve this problem. There are, however, people who are sufficiently callous and apathetic in matters scientific as to view with suspicion, if not with absolute disapproval, any proposal to drag heavy trail ropes over towns, villages, buildings, or even cultivated fields. But there is no necessity for the trail ropes to be employed from the very start, and the first stage of the voyage might be effected with the ropes stowed away in the car (which fact would reduce the chances of a hitch at starting) ready to be let down as soon as some less inhabited country is entered upon.

Once the trail rope has begun to drag along the ground, the only way of ascending clear of the ground is by throwing out ballast of a weight equivalent to that of the portion of the rope resting on the ground. But fortunately this sudden undesirable discharge of ballast need not be resorted to except in a case of emergency, for it was proved experimentally that by the adoption of the steering arrangement employed by Andrée most obstacles which can be seen a reasonable distance ahead can be avoided.

Leaving out the trail rope, which we will suppose to be already decided on, the additional weight of the sail and fittings required is comparatively small, and can be arranged to be discarded as ballast if necessary; the additional risk is nil, a certain measure of utility is assured, and the possibility of achieving still more satisfactory results well worth the slight additional trouble involved.

The invention of this trail rope and sail combination is usually attributed to Green early in this century, but others give the credit to Professor Kratzenstein, of Copenhagen, who is said to have suggested it a few years after the balloon was invented, about 1784. The recorded experiments made with the trail rope and sail combination date back from 1886, when M. Hervé obtained a deviation of 65° to 70° by using this means. A detailed account of the apparatus employed and the conditions which prevailed would be of great value. After this come the preliminary experiments of Andrée in 1895 to 1897, a short land trial by representatives of the *Times* and *Daily Chronicle* in November last; a cross-Channel trip in December by the *Times* and *Daily Chronicle* balloon, during which brief experiments were carried out; and an experiment by some German officers this spring. Andrée is said to have obtained a deflection of 12°, and to have based a hope on his experiments of attaining a deviation of 30° on either side of the direction of the wind. The *Times* and *Daily Chronicle* balloon deviated 14° on each side of the direction of the wind, on the occasion of their first trial; and in the cross-Channel trip, during successive brief trials, recorded a deviation of 30°, the conditions differing from the former trip in that the sail was over twice as large, and the balloon appeared to be retarded more. The details of the experiments made by the German officers are not published, but the aeronauts reported that the steering gear acted to their complete satisfaction.

For the benefit of those readers who are not already acquainted with the principle of this method of steering balloons, it may be

mentioned that the resistance of the trail rope dragging along the ground by retarding the balloon causes a breeze relative to it. The sail, which is made fast more or less in a vertical plane depending on the method of fixing, is adjusted so that it is inclined horizontally to the direction of the above breeze, which acts on it and deflects the course of the balloon somewhat in the same way that a rudder causes a lateral force to act on the stern of a boat.

The conditions are too varied and unknown to admit of a reliable theoretical computation of the maximum possible deflection under the most favourable circumstances, or of an exact prediction of the combination best suited for the purpose. Nevertheless the main principles governing the design of the apparatus are fairly clear, and, neglecting the case of an elongated balloon, which it is not intended to consider here, the principal points to be aimed at are as large a sail area as possible and the maximum safe retardation of the balloon. The sail can always be trimmed at the most advantageous horizontal angle for steering by shifting the point of attachment of the trail rope to the main hoop. In this latter connection the angle which the plane of the sail makes with the *vertical* deserves consideration. If only one inclined sail is used, this should always be kept on the windward side of the balloon when trailing. If this is done, unless the balloon is blown over by the wind at an angle greater than that made by the plane of the sail to the axis of the balloon, the wind due to the retardation of the balloon tends to exert an upward force on the sail, which acts to a slight extent like an aeroplane, and assists in preventing the balloon from being beaten down by the wind. If the sail is on the lee side, the balloon is exposed to a downward force due to the sail acting as an inverted aeroplane. Whatever combination of sails is adopted, and probably two or three can be advantageously introduced, it might be well worth while trying to arrange that they can be trimmed so as to present at least a vertical surface if not a favourably inclined one to the wind. Perhaps also it might be worth while rigging up a small aeroplane under the car so as to obtain a slight temporary increased buoyancy at the very moment when it is most required to prevent the balloon from being blown down dangerously near the ground or sea.

It would seem as the result of the experiments which have already been made that it is not unreasonable to hope for a deviation of 20° to 30° when the conditions are better known, and the apparatus is improved correspondingly, and, though the problem of dirigeable balloons will not thereby be solved by a long way, and obviously, indeed, cannot be completely solved by this method, yet even this amount of control over the direction taken opens up large possibilities in long-distance ballooning. Andrée's well-thought-out and daring scheme to reach the North Pole by balloon was not by any means devoid of the elements of success, and there is no reason why the Pole should not be discovered in this way if the direction of the wind could be counted on as being within 20° of true north. It would be advisable, however, before committing the lives of brave men to the risk of the comparatively unknown dangers involved by a similar attempt, to carry out large scale experiments over land and sea in more congenial climes, and in places where failure need not necessarily spell disaster.

First of all there is need of short preliminary voyages, after the manner of the recent cross-Channel trip of the *Times* and *Daily Chronicle* balloon. By this means indications will be obtained of the most suitable appliances, and the experience thus gained would justify, for example, an attempt to cross the Atlantic in a balloon. The regularity of the trade winds encourages the attempt, which would possibly be most favourably undertaken along the wind belt between, say, Gibraltar and Venezuela. The direction of the wind being inclined to that of the belt according to Ferrel's law, it would be imperative to use the sail and trail rope or other means of steering to avoid the belts of calm to the north and south of this wind belt. In case of failure there would always remain the chance of obtaining assistance from passing vessels. There does not seem to be any reason to doubt the practicability of this voyage, which would be justified as a preliminary to another attempt to reach the North Pole by balloon.

Whatever may be the exact nature of the reported trials to be made by Berlin aeronauts, any further investigations which may tend to throw more light on the subject of such importance as aerial navigation cannot fail to be followed by world-wide interest and attention.

It has occurred to me since I wrote my article on this subject that for over-sea voyages at least it might be a good plan to make the trail rope, or ropes, not only smooth enough for safety, but as smooth as possible, and to have at the end of a wire some suitable form

of obstruction which could be let down and dragged behind when it is desired to retard the balloon. The advantages would be that, except when it is intended to steer the balloon out of the direction of the wind, the retarding apparatus would be drawn up clear of the water and the trail rope, while fulfilling its height-regulating functions, would not diminish the velocity of the balloon to an unnecessary extent; also that the amount of obstruction could be arranged to be varied according to the needs of each case. Experiment alone can prove whether the rope can be made smooth enough to justify this expedient.

It would be of considerable value if reliable observations could be made, during the experiments, of the velocity of the balloon relative to the earth, and of the velocity of the wind relative to the balloon, the sum of these two giving, of course, the velocity of the wind relative to the earth. Two ingenious methods were adopted by Andrée for measuring the former, but they are only applicable over land or where fixed points are available for observation. Letting alone complicated and probably unreliable methods depending on the pull of the rope and the length immersed, the only practicable way seems to be to use a small log. The velocity of the wind relative to the balloon can be measured by an anemometer on the balloon.

M.

War Ballooning in Cuba.

The following extracts from the official report of Lt.-Col. J. E. Maxfield, U.S. Volunteer Signal Corps, to the Chief Signal Officer, U.S.A., are interesting, and give a very different version of the affair to that quoted from the New York "World" in this Journal for January last:—

"The apparatus already in the possession of the corps embraced 1 silk balloon, 1 small generator (which was out of repair), 1 small gas compressor (also out of repair), 180 steel tubes for holding compressed hydrogen, 1 balloon wagon, 1 wagon for the carriage of tools and miscellaneous supplies, and 5 wagons for the carriage of the gas tubes. Both the compressor and generator, while large enough for use for purposes of instruction, were too small to give good results in actual service. * * * Both in the repairing of the apparatus already on hand and in the ordering of new, great difficulty was had in finding firms who could, without delay, perform the necessary work. In spite of these difficulties, by the middle of May all the apparatus on hand at the beginning of the war had been placed in thorough repair, the work upon the new apparatus was approaching completion, and orders had been placed for the necessary tools and material for the generation of gas. During the latter part of this work I had the assistance of Mr. L. B. Wildman, aeronautical engineer, afterwards first lieutenant, United States Volunteer Signal Corps. As fast as the materials and apparatus were ready they were shipped to Tampa, Fla., at which point it was decided to erect the permanent gas plant, at least temporarily. Much delay occurred in the shipment of the balloon material from Fort Wadsworth, owing to its great weight and the lack of men to properly handle it, the garrison at that time being small and engaged in other work. In addition to having placed in thorough repair all the apparatus on hand, there was purchased 1 portable gas generator, 1 semiportable generator of large size, 3 balloons, 1 compressor of the capacity of 25,000 cubic feet per day, 1 large sheet-iron gasometer, 5,000 feet of balloon cable, an additional cable reel so designed as to be easily placed in an army wagon and dismounted at will, 1 portable boiler for the operation of the gas generator, 1 large stationary boiler for the operation of the compressor. In addition there was also purchased a large variety of tools of all kinds suitable for working both in wood and metal, to enable repairs to be readily made in the field. Large quantities of iron turnings and sulphuric acid for the generation of hydrogen were also shipped to Tampa. By the middle of May all orders had been placed and work had progressed, so that it was possible for me to leave New York and to proceed to Tampa for the purpose of organising the balloon companies. * * * Ten men of the Signal Corps, United States Army, from Chickamauga, 4 from Atlanta, and 10 from Major Greene's command at Tampa, had in the meantime reported to me for duty. Major Greene also placed at my disposal the services of Second Lieut. George C. Burnell, United States Volunteer Signal Corps, and the promotion of Sergt. Walter S. Volkmar to the grade of second lieutenant gave me two officers. * * * The next day was the one devoted by the troops to the loading of the transports. It was found that no assignment to any transport had been made for the balloon detachment, and it was only after some time and by the order of the commanding general that such assignment was obtained. The cars con-

taining the balloon material were found early in the morning, and by placing an officer upon the train of which they formed a part, these cars were at last brought opposite the designated transport, the 'Rio Grande,' and the supplies unloaded. Loading upon the transport at once began, but owing to the fact that the carboys of sulphuric acid could not be placed in the hold but had to be hoisted up over the ship's side, it was not until the next morning that the loading was completed. Lieut. James R. Steele, United States Volunteer Signal Corps, reported to me before the sailing of the expedition. On June 22 the landing of the troops of the expedition began at Daiquiri. * * * Landing was completed on the morning of the 28th, the equipment loaded upon seven army wagons, and the march to the front began. Owing to the condition of the roads it was found necessary several times to partially unload the wagons at bog-holes, and it was not until that night that Siboney was reached. I reported to the commanding general that night and received instructions to continue the march the next morning and report to him at whatever point should be established at his headquarters upon my arrival. The detachment reached headquarters early in the afternoon of the 29th, but a heavy rainstorm prevented any work being done with the balloon that day. On the next day the balloon was spread. It was found that the extreme heat had softened the varnish so that the two sides of the envelope were stuck together. It was also found that either from scorching or the use of improper varnish portions of the balloon were badly rotted. This balloon was the old balloon in the possession of the corps at the beginning of the war. After the envelope had been fully spread, numerous small holes in it were found, as well as several rents of considerable extent. It was in such condition that had the ascents to be made in time of peace it would have been felt unsafe to use it. The rents were carefully sewn and covered with adhesive plaster and the balloon inflated. Three ascents were made that afternoon—the first by myself and Sergeant Baldwin, Signal Corps, United States Army; the second by Second Lieut. Walter S. Volkmar, General Castillo, of the Cuban Army, being carried as a passenger; and the third by the chief engineer officer of the Fifth Army Corps and myself. These ascents resulted in an increase of knowledge as to the direction and course of roads and streams immediately in our front. The fact that the Spanish fleet of Admiral Cervera was in the harbour of Santiago was at last definitely settled. It could not be determined, however, how strongly the fortifications in our front were held, nor could they be located except with the greatest difficulty. A most flattering verbal report as to the value of the balloon in war was made by the chief engineer officer to the commanding general, with the recommendation that it be employed during the battle planned for the next day. That evening verbal orders were brought me by the chief engineer officer of the Fifth Army Corps from the commanding general to report with the balloon, at as early an hour as practicable, at El Poso, which was to be the headquarters of the commanding general during the battle, and that there I would find the chief engineer officer who would accompany me in the ascents. The balloon was secured in the most sheltered place possible for the night, and the detachment rose at daybreak and proceeded to replace the gas which had been lost during the night. It was also found that new rents had been caused by the wind during the night, which had to be repaired before the balloon could be used. As soon as these repairs were completed the detachment took up its march for El Poso, towing the balloon by means of captive ropes. * * * Here I met Lieutenant.-Colonel Derby, and the balloon was carried to a place in the river bottom, about a quarter of a mile to the rear, and an ascent made, Colonel Derby and myself occupying the basket. From this point a message was sent to the adjutant-general of the corps, setting forth the movement of troops both at El Caney on our right and upon the road to our front, which led to the hill at San Juan. Under orders from the chief engineer officer, the balloon was then pulled down to within a few hundred feet of the ground—the occupants of the basket still remaining in it—and towed towards the front until a more suitable position for viewing the intrenchments at San Juan could be found. It was supposed that the balloon would be halted at El Poso, and that point taken as a station for the balloon detachment, as had been originally intended. As this was not done, a statement was made by me as to the results of artillery firing at balloons in experimental work abroad, and the conclusions to be drawn from such, and the fact stated that in my opinion it was unwise to carry the balloon farther to the front. No formal protest, however, was made, as it was felt that the chief engineer officer was the representative of the commanding general and that his desires were to be carried out. As a consequence, the balloon was carried rapidly to the front until it was immediately in the rear of the troops, who were

then deploying for an attack upon the block-house and trenches on the San Juan Hill. As no further progress to the front could be made, the balloon was then carried across the bed of the San Juan River and into a large meadow just to the right of the road and river. In passing through the trees and brush along the river banks the ropes holding the balloon captive became badly tangled in this brush, and no movement for a time was possible; nor, for the same reason, could the balloon be given the necessary elevation to enable it to do its best work. Nevertheless, from this position the fact was determined that the intrenchments on the San Juan Hill immediately in our front were strongly held, and a message to this effect sent to the commanding general with the suggestion that the artillery upon the hill at El Poso should reopen its fire upon them. This was done. The attention of the occupants of the basket was given almost solely to an examination of the ground held by the enemy and that immediately in their front, and it is impossible for that reason to state what was the disposition of our own troops in the immediate vicinity, most of whom were hidden by the brush. It was noticed, however, that dismounted cavalry were deploying in the open meadow in which was the balloon, about fifty yards in our front. It was at that time that the enemy opened fire. This fire appeared to be musketry alone. In a very few minutes it became apparent that the balloon had been struck, as there was a decided loss of gas, and the rope having not yet been cleared from the brush I gave the order that the balloon should be pulled down, hoping to be able to disentangle it, carry it to the rear, repair the holes in it, and replace the lost gas from the tubes which still remained full. This order was obeyed, and for twenty or thirty minutes the detachment was busy endeavouring to disentangle the captive cord and extend it along the bed of the river. During this work the detachment was exposed to a heavy musketry fire, from which they were fortunately fairly well sheltered by the banks of the river, and although the leaves oftentimes fell in showers from the bushes and trees overhanging the bank, but one man, Private Heywood, Signal Corps, United States Army, was struck, he receiving a wound in the foot. An examination of the balloon having shown several holes in the upper portion, and the loss of so much gas as to render the further use of it impossible, orders were given to secure it and to retreat along the river bottom. This was done, and the detachment in a short time reported at El Poso. Later in the day Second Lieut. Walter S. Volkmar was instructed to make an examination of the balloon and report whether it had been so badly damaged as to render its recovery useless. He reported that the gas had entirely escaped, and that there were numerous holes and rents in the envelope, which would render it totally unserviceable for future use in the field where facilities for repairs upon a large scale were lacking. He, however, folded the balloon, and placed it in the basket, and it was afterwards recovered and brought to Siboney. * * * The difficulties met with in securing the rapid manufacture of apparatus needed have already been referred to. No less difficulty was found in securing the services of experts in the varnishing and care of balloons. While in New York innumerable applications for enlistment were received from professional aeronauts, but it was found to be wholly impossible to obtain the services of men of the class desired. The American aeronaut, making his ascensions as he does for purposes of exhibition only, desires to land in the shortest possible time. It is therefore a matter of little importance to him whether his envelope is made highly impermeable to the gas contained in it or not, and the result is that he knows little or nothing about the proper processes to be employed in making and keeping the envelope highly impermeable. It is understood that the services of two French experts were offered after I left New York, but only at the most exorbitant salaries. In spite of the difficulties met with, however, it can be said that within five weeks after the declaration of war the Signal Corps was able to put a fully equipped balloon train in the field, and that by the time the companies of the Volunteer Signal Corps had been organised and were ready for service another train was practically completed. At the time of the cessation of hostilities, one set of equipment was at Santiago de Cuba, with all the necessary apparatus and material for making balloon ascensions, although work could not have been done with it as rapidly as would have been the case had a fresh supply of tubes containing compressed gas been available. Another balloon section was at Tampa, likewise fully equipped. As regards the conclusion to be drawn from the work of the balloon section in the campaign of Santiago, in its bearing as to the value of the use of the balloon in warfare, a few remarks may be useful. As has been stated above, the use of the balloon in this campaign was very limited. Had it been brought ashore and used daily from the time of landing until the day of the battle upon July 1, it is believed

a large amount of exceedingly valuable information would have been obtained. As it was, the few ascents made on the afternoon of June 30 were not rich in results, although some additions to the map of the country in our front were made possible by them. On July 1 at least two items of information of value were obtained by the use of the balloon. These were as follows: First, the fact that the intrenchments at or near the hill of San Juan were strongly held by the enemy. The obtaining of this information resulted in the opening of fire by the battery at the hill of El Poso earlier than would have otherwise been the case. Second, the official report of Brigadier-General Kent, commanding the First Division, Fifth Army Corps, as published in the press, states: 'The enemy's infantry fire, steadily increasing in intensity, now came from all directions, not only from the front and the dense tropical thickets on our flanks, but from sharpshooters thickly posted in trees in our rear, and from shrapnel apparently aimed at the balloon. Lieutenant-Colonel Derby, of General Shafter's staff, met me about this time and informed me that a trail or narrow way had been discovered from the balloon a short distance back leading to the left to a ford lower down the stream. I hastened to the forks made by this road, and soon after the Seventy-first New York Regiment of Hawkin's Brigade came up. I turned them into the bypath indicated by Lieutenant-Colonel Derby leading to the lower ford, sending word to General Hawkins of this movement. This would have speedily delivered them in their proper place on the left of their brigade.' The country in which the army was operating was covered with brush and trees, and, moreover, was hilly. Such a country is the one least likely to afford to the balloon a good opportunity of proving its usefulness. Movements and positions which upon a flat, open country could have been easily distinguished from the basket of a balloon, and in no other way, were hidden or only discerned with the greatest difficulty. * * * The balloon used in the Santiago campaign was one of about 15,000 cubic feet capacity. This raised the two observers, the necessary instruments, and the captive cord, but not enough ballast could be carried to give easy control of the balloon in case it had broken away; furthermore, even in a slight wind it was found that the lifting power of the balloon was sensibly lowered. It is, therefore, believed that balloons employed for military reconnaissance should be of at the least 18,000 cubic feet capacity. The use of gas compressed in steel cylinders for the inflation of the balloon seems to be the best method until new processes of generation of hydrogen shall have been discovered, thus enabling portable generators of light weight to be utilised. The present portable generator to be of sufficient capacity is almost too large and too heavy to be moved over rough roads, while the weight of the material for the generation of the gas is excessive. It would, therefore, seem preferable, wherever possible, to place the generator at the base of operations and to keep the balloon supplied with gas by the shipment to the front of tubes. The carriage of large quantities of sulphuric acid is difficult when carried in carboys, as was the case during the Santiago campaign. It was found that the stoppers often were knocked out or the necks of the carboys broken while being transported. On the other hand, the carriage of acid in lead-lined iron cylinders, while much more convenient, offers the objection that even the slightest hole in the lead lining will lead to leakage of the acid, and possibly a serious accident. It is also believed that it would be better in the case of field operations, where expense is a matter of minor importance, to substitute ingots of zinc for the iron turnings ordinarily used. By doing this a greater rapidity of generation would be secured and less transportation would be required. Taken as a whole, the present apparatus for balloon work is cumbersome, and can be transported over bad roads only with great difficulty. There is a wide field for improvement, and it is to be hoped that in the coming years sufficient appropriations may be secured to enable a thorough series of experiments to be made looking toward the finding of new methods of generation and the lightening of the apparatus employed and the weight of material used."

The Fatal Accident to Mr. Pilcher.

It is with the most profound regret that we have to chronicle, at the last moment, an event of the most sorrowful and regrettable nature. It is an event not only detrimental to the progress of aerial navigation, and deterring to others pursuing the same promising line, but it is one which deprives us of one of our most ardent workers, one of the cleverest, most practical, and most energetic of aerial experimenters.

Percy Sinclair Pilcher was born in January, 1866. He early entered the Navy, but retired after seven years' service, and took up civil engineering. After regularly going through the shops at Glasgow, he was for a couple of years with the Maxim Nordenfeldt Company, and lately became a partner in the engineering firm of Wilson and Pilcher. He joined the Aeronautical Society in March, 1897, being elected to the Council in November of that year. Mr. Pilcher first began experimenting with soaring machines about 1894, when he got a Lilienthal machine, and later improved upon it, building several new models. He adopted a method of experiment which was a distinct step over Lilienthal's descents from a hill top, and that was to tow the machine by means of a long cord over the flat, and thus to rise somewhat on the principle of a kite, but with the string attached to the front edge. It was on Saturday, September 30th, that Mr. Pilcher gave his last exhibition. He had been staying with Lord

Photo by *S. Koenig.*

PERCY S. PILCHER.

Braye, at Stanford Park, near Market Harborough, and a number of friends from the neighbourhood came over to witness the event. Among those present were his poor sister, the Hon. A. Verney Cave, Mr. Henniker Heaton, M.P., Major Baden-Powell, and others. The afternoon proved very unfavourable, with frequent light showers and a gusty wind. However, after making some trials with the kites which Mr. Hargraves presented to the Aeronautical Society, it was decided to try some flights with the old soaring machine, a beautifully made new three-decked machine, somewhat similar to that tried by Mr. Chanute, being also brought out. The string, a very light cotton line, perhaps 300 or 400 yards long,

was attached to the fall of a tackle, which was drawn away by a couple of horses. By this arrangement the speed of the horses was multiplied several times. On the first trial the apparatus appeared to go very well. It rose easily into the wind after a short run, but just as it was getting up the string broke, and Mr. Pilcher gently descended to the ground, just as any large bird might do. The machine was then taken back for a fresh start, the inventor remarking that the rain had made the machine very heavy, and that it was difficult to get up the desired speed. The second attempt was more successful still, the apparatus easily rising up to about thirty feet. (It was, of course, extremely difficult to judge with any certainty the exact height.) Just then, a snap was heard, the tail was seen to collapse, and the apparatus dived forward, and probably turned completely over before it reached the ground, a shattered wreck. Mr. Pilcher lay motionless, moaning and unconscious. It was painfully evident that his left leg was broken high up on the thigh, but no other traces of injury were apparent. Luckily, two doctors were present among the onlookers, and promptly rendered assistance. The unfortunate victim was with some difficulty got free from the wreckage, placed on a door, and carried to Stanford Hall. After a careful examination by the doctors, a somewhat hopeful bulletin was issued, stating that there was no apparent injury to head or spine. Consciousness, however, did not return, and after lingering on through Sunday, the sad end came on Monday morning.

An examination of the wrecked machine revealed the fact that the probable cause of the accident was due to the canvas of the tail shrinking from the wet, and thus breaking the bamboo stretcher. Though, of course, this conclusion is but a surmise.

Thus ended what was, from a scientific point of view, one of the most successful flights ever made by man. The fact of rising up from the level ground many feet into the air, solely by the aid of being towed by a very light line, is a

triumph, proving that if that small amount of pull had been derived from a screw propeller such as Mr. Pilcher had actually made, though never tried, it would have gone equally well. But there is an important moral to be learnt from this abrupt descent. Such an apparatus *must* be so constructed that if one little portion breaks, the balance of the machine will not be wholly destroyed thereby.

We are able to reproduce a photograph of Mr. Pilcher in his machine, which if not a good one, is of great interest as having been taken but a few minutes before the fatal accident.

NOTES.

Professor Langley's Machine.—Notwithstanding some awe inspiring and highly suggestive accounts which have recently appeared in the papers with respect to this apparatus, we have the highest authority for stating that the trials have been conducted in great privacy, and that no details will be published just yet as to what is being done. Most of the newspaper reports are wholly unreliable, many merely referring to those experiments which this inventor conducted over three years ago, and others having been concocted by the fertile brain of the "copy-writer."

Balloon Accidents.—During the last few months there have been more slight accidents to balloons than is usual or desirable. The first incident to relate can perhaps hardly be called an accident, though it was not the fault of the aeronaut in charge that it was not so. Mr. Reuben Bramhall was to make an ascent in his balloon from Bradford, taking two passengers, Mr. J. J. Schmidt and Mr. T. Croft. The aeronaut, presumably with the idea of impressing the audience with his *savoir faire*, stood on the edge of the car at the start. But through bad management the balloon dragged through some bushes, and swept Mr. Bramhall off his perilous perch, while the balloon, relieved of his weight, shot up into the air with the two unfortunate amateurs. Luckily they kept their heads, and successfully brought the balloon to earth, after a trip of 27 miles.

The same aeronaut a few days later had another nasty mishap, which certainly does not look well for his capabilities as an aeronaut. During the inflation of his balloon, a strong gust dragged it from its moorings, and drove it across the ground, where it got badly torn on the fencing, the aeronaut himself being dragged some distance entangled in the netting.

On last Bank holiday, there occurred what one of the evening papers described in its poster as "A terrible balloon catastrophe at the Crystal Palace." It seems that owing to an oversight, the balloon ascended with the neck tied up. After rising about 500 ft., a rent appeared, said to be caused by the internal pressure of the gas, and the balloon descended so rapidly that it came down on the roof of a house, but luckily without the occupants of the car receiving any injury.

More serious accidents have unfortunately occurred abroad. An Italian military captive balloon broke loose in July, carrying with it not only an officer and a corporal who were in the car, but also a soldier who had held on to the rope in hopes of keeping the balloon down. Those in the car tried to draw up the unfortunate man, but after a time he let go, and was dashed to pieces on the banks of the Tiber. The aeronauts then made a very rough descent, the corporal sustaining a fracture of the leg.

At Beuzeville, in France, an aeronaut, named Bernard, made an ascent, but finding his balloon had too little lift, he dispensed with the car, and sat upon the hoop. It is supposed that the gas from the balloon issuing through the neck must have asphyxiated him, for he was seen to let go his hold and fall to the ground from a great height, being killed on the spot. The *Revue Scientifique* says this brings the number of victims of ballooning up to about 200.

The Peace Conference.—The great conference at the Hague, so boldly heralded as the foundation of the international compact to absolutely do away with war and bring everlasting peace, has ended. And with what result? A very detailed modification of a certain form of bullet has been, by some nations only, prohibited; the use of asphyxiating gases, a system of warfare not only never practically tried, but probably never even seriously considered, has been condemned; and thirdly, the discharge of projectiles or explosives from balloons or aerial machines has been prohibited (for five years) by all the nations. It is this last resolution that is of special interest to our readers, since the perfected aerial machine was always supposed to be the most powerful engine of war, chiefly on account of the ability to drop explosives on any desired

spot. But there are still many doubtful points to be decided. Does this preclude an aeronaut from dropping any article from a balloon with intent to do damage? If not he may rain down as many bullets as he likes, and can presumably drop over anything that is not explosive, such as fire brands, molten lead, or acids! Then, again, what is the definition of "throwing" projectiles and explosives? May an aeronaut carry a charge in the balloon, descend at a given spot, and plant it, with a time fuse attached? If so, may he, instead of descending himself, lower it to the ground by means of a rope? Then again, does this refer to small balloons carrying only a charge of explosives without a man? If so, does it apply to a small flying machine? Then where does the difference between a flying machine and a rocket come in? No, let us rather encourage this all-powerful aerial warfare, and we should be much more likely to approach the era of universal peace.

The Theory of Balloon Ascent. — Dr. Hergesell, of Strassburg, has contributed to the *Illustrated Aeronautical Magazine* (No. 4, *Jahrgang* 1899) a mathematical investigation of the theoretical vertical movements of a free balloon. The subject engaged the attention of Mr. J. Glaisher in the *Encyclopaedia Britannica*, and is of considerable interest for scientific balloon navigation. The first case considered is that of the ascent of an imperfectly inflated balloon, and the formulæ give the velocity attained in a stratum of air of a definite density, *i.e.* at a definite altitude, and the time required in reaching this stratum. In the case of a perfectly inflated balloon, the investigation shows that the maximum height that can be attained depends entirely upon the lifting power, and that it is independent of the velocity of ascent, and of the resistance of the air. In the case of the descent of a balloon, it is shown that the velocity of the fall does not continually increase, as is often stated, but, on the contrary, decreases, and that there is no danger in allowing the balloon to descend from a great altitude without throwing out ballast, as the velocity of the descent decreases according to the greater height from which the descent is made. —*Nature.*

More Cross-Channel Balloon Trips.—On July 29th, Mr. Percival Spencer, accompanied by Mr. Pollock, started at 2.30 from the Crystal Palace. At 5.3 p.m., the balloon, at a height of 7,000 ft., passed out to sea near Hastings. By half-past seven the ballast was all exhausted, and shortly after the anchor was cut away and thrown out. The balloon then ascended to 12,000 ft., and at last, after 8 p.m., the French coast was reached, and a descent made between Dieppe and Treport.

On Aug. 15th, Mr. Percival Spencer made another ascent, and again crossed the Channel from Dover. It had been proposed to make the ascent the day before, before the members of the British Association, but the elements were not favourable, so early next morning Mr. Spencer and a companion ascended. Starting with a favourable N.N.W. wind, the balloon soon changed its course to the eastward, but after 2½ hours descended safely near Dunkirk, the distance being about 23 miles.

Kites for Meteorology.—At the recent meeting of the British Association at Dover, Mr. A. L. Rotch gave an interesting account of the work done at the Blue Hill Observatory during the last year. The average heights of the 10 kite ascents made during the first four months of 1899 was 7,680 ft. The maximum neight was attained on Feb. 28th with an altitude of 12,440 ft. above the sea. The Hargrave kite with curved surfaces was found to be the most satisfactory form, owing to its simpler construction.

M. Teisserenc de Bort has been using kites regularly during the last year at the meteorological observatory at Trappes, several very high flights have been made, surpassing even those at Blue Hill, the greatest, made in August, having attained 14,107 ft.

Aeronauts versus Cyclists.—A curious competition, in which balloonists and cyclists participated, took place at Paris on 10th July. Four balloons, each carrying a cyclist with his machine, started from the Tuileries Gardens at five o'clock last night, their object being to descend at some distant point where the aeronaut could pack up his balloon and the cyclist despatch a telegram before being captured by their pursuers mounted on bicycles and motor cycles. The pursuers had an hour's start, taking their direction from a number of small pilot balloons, and they succeeded in capturing one of the aeronauts and his bicyclist near Ablon. M. Santos-Dumont, however, descended at Corbeil and escaped.

Important Observations have been made recently by Dr. J. Tuma, from balloons, for the purpose of obtaining measurements of the distribution of atmospheric electricity in clear weather, and of determining whether the balloon itself receives electrical discharges. The latter point is one of considerable interest,

in view of the burning of several balloons lately while up in the air. Out of seven ascents all the observations show that the positive potential decreases with increasing height, and is, therefore, apparently accumulated in the lower strata of the atmosphere. During the last four ascents Dr. Tuma was unable to find that the balloons were electrically charged.

Obituary.

M. Gaston Tissandier.

Gaston Tissandier, the famous balloonist and scientific writer, has just died, after a long illness, in his fifty-sixth year. The deceased aeronaut was born in Paris, and after having studied chemistry and physics with energy he took to ballooning with his brother Albert. They made nearly fifty ascents together, four being effected during the siege of Paris by the Germans. They were then attached as balloonists to the army of the Loire. In 1875 the deceased made the famous ascent in the Zenith balloon, which led to the deaths of his two companions, Croce Spinelli and Sivel. They went up a tremendous distance, 8,600 metres according to French reckoning, and Gaston Tissandier showed a marvellous resisting power on the occasion. This fatality did not check his ardour, for he soon afterwards made further ascents with his brother. They notably tried an electric navigable balloon about sixteen years since, and obtained thereby some useful results. M. Gaston Tissandier wrote many important scientific treatises in his time, and was a diligent contributor to reviews on chemical, meteorological, and aeronautic subjects. He and his brother also founded "Nature," a most useful periodical for all who are interested in the marvels of sea, sky, and land. One of his latest books was the "Martyrs of Science," and he has left behind some manuscripts which are of great scientific import and value.

Recent Publications.

"On Soaring Flight," by E. C. Huffaker, is a pamphlet published by the Smithsonian Institute. An introduction by Prof. Langley explains its contents. Of the two general methods of flight, the first, by the direct exercise of mechanical power, in which "there is nothing, considered as a mechanical contrivance, in apparent contradiction to known principles." Whereas the second, in which "birds can fly without flapping the wings, and are able to glide over the landscape on nearly motionless pinions, has never yet been completely accounted for," and this forms the special subject of the article.

In considering the various different methods by which this might be accomplished, Prof. Langley, dismissing the palpably absurd theories of the specific gravity of the bird being much lighter than air, or that of being sustained by wind on the principle of kites, speaks of ascending currents of air, which cannot be universally present, since "what goes up must come down." Two strata of air moving at different velocities might account for the mechanical possibility. So might the many undulations and eddies which may be found in the air. Still none of these explanations seem satisfactory, and adds, "we seem, then, to have exhausted every suggestion, and yet the soaring bird still soars and remains sustained in mid-air almost without an effort."

The theory now advanced by Mr. Huffaker may be shortly described as follows. The surface of the earth absorbing a certain amount of heat from the sun, warms the strata of air immediately above it. For various reasons this warm air does not immediately rise, but hangs like a mist near the surface of the earth. When, however, any local disturbance takes place, a column of the air is able to rise through the cooler strata, a "chimney" is formed, up which the warm air can rush with a velocity sufficient to carry up small articles, such as the sand column seen in the desert, or light strands of silk, as tried by the author. The suggestion is that a large bird by flying around flapping his wings is able to form such an upward moving column of air, which, once formed, is able to carry up any soaring birds which come to that spot, and thus they are able to spirally ascend to a considerable height, and then soar away to their destination.

This theory, novel as it may be, and correct in mechanical theory, seems, however, to be a little wanting. Such ascending currents—if they exist—can but be of the lightest description, and it seems scarcely possible to believe they could be sufficiently powerful to lift a heavy bird to a great height. Even the author owns the difficulty of the problem, and adds, what is very true, "some sort of solution is

desirable, if only to give direction to our investigations."

"LES MOTEURS LEGERS APPLICABLE A L'INDUSTRIE, AUX CYCLES ET AUTOMOBILES, A L'AERONAUTIQUE, L'AVIATION, &C." H. de Graffigny. 8vo, 332 pp. Paris: E. Bernard.

The title of this work sufficiently indicates the nature of its contents, giving theoretical and practical information chiefly about steam, petroleum, and electric engines, but also referring to other kinds. In comparing the relative weights of engines, with water, fuel, acids, &c., for one hour's consumption, the following interesting figures are given:—

	For a small Engine of about 1 H.P.	For larger Engines over 20 H.P.
Steam	100 kilo. per h.p.	40 kilo. per h.p.
Oil	20 ,, ,,	15 ,, ,,
Electricity	35 ,, ,,	25 ,, ,,

The oil engine is therefore considered altogether the lightest motive force.

"ETUDE SUR LA NAVIGATION AERIENNE." P. Girardville, Captain of Artillery. 30 pp., 10 figs. Paris: Berger-Levrault & Co.; 1899. Is a complete little résumé of the subject, dealing with navigable balloons, aeroplanes, and the flight of birds.

Foreign Aeronautical Periodicals.

L'AERONAUTE (Paris).

July.—Congrès International de 1900, with report of the Secretary of the Permanent Commission of Aeronautics, setting forth the programme of matters to be discussed at the various meetings.—Proceedings of the Société de Navigation Aérienne.—Committee of Aerostation.—Closed Car for Sounding Balloons (M. J. Paloux).—Ader's Apparatus, further details, stating it is to be exhibited at the Exhibition next year.

August.—Circular about the International Congress of Aeronautics of 1900. No date is yet fixed for its assembly.—The Aeronautical Exhibition at Munich. There are twenty exhibitors, including the Bavarian and the Prussian Aeronautic detachments.—Apparatus for determining the "gas retaining qualities of materials," by S. A. Andrée (with illustration).—"Thirteen Hours in a Balloon:" MM. Nicolleau, Capitaine Lebihan, and Feneuil ascended from Nantes at 5 p.m. on July 14th, and descended at 3 o'clock in the morning, near Baugé, whence they reascended.

September.—Gaston Tissandier: Life and portrait.—Meeting of the International Meteorological Committee.—Account of Ascents.—Women Aeronauts.—How a Balloon is made.

LA FRANCE AERIENNE (Paris).

1—15 *July.*—An Italian Soldier's Fall of 500 m.

15—31 *July.*—Aeronautics at the Exposition of 1900.—Ascent at Melun.

1—15 *August.*—Aeronautics and the accidents of work.—The 14th of July in the Provinces: Ascents at Mans, Lyons, and Epernay.—Necrology: The aeronaut Bernard.—Fantaisie Aerienne.

15—31 *August.*—Fantaisie (*continued*).—Necrology: Lt. Georges Houtelart.—Recollections of the Siege of Paris.

1—15 *September.*—Aeronautics from day to day.—Recollections of the Siege of Paris (*continued*).—Review of the Foreign Press: The *New York Herald* on M. de Bausset's ideas.

15—30 *September.*—An Ascent at Sartrouville.—Cycling and Military Ballooning.—Recollections of the Siege of Paris (*continued*).—Dirigible Balloon of M. Anastasin in Roumania (only an idea).

L'AEROPHILE (Paris).

September.—Portraits of Contemporary Aeronauts: M. E. Archdeacon (with portrait).—Results obtained by the Aid of Sounding Balloons.—From Munich to Vienna by Balloon.—The Latest Crossing of the Channel.—Death of M. Gaston Tissandier.—An Aerial Velocipede (illustrated): Mr. Carl Myers in United States. Balloon of 4,000 cubic feet, with a seven foot screw propeller worked by treddles.—Notes.

ZEITSCHRIFT FUR LUFTSCHIFFAHRT (Berlin).

June.—The Way to the Destination: A. Stentzel.—Studies in Aerodynamics: Josef Popper.—Notes.—The Shifting Equilibrium in Suspense.

July.—The Lifting Power of the Wind: F. Ritter.—V. Loessl's "Aerodynamical

State of Suspense of thin Planes"—On Buttenstedt's Theory of Flight.—Notes.

August.—On Military Ballooning: F. Hinterstoisser.—The Theory of the Kress Aeroplane.—Notes.—Reviews of Books.

ILLUSTRIRTE AERONAUTISCHE MITTHEILUNGEN (Strassburg).

July.—Frontispiece. Aeronautical Caricatures.—C. Kramp and Aeronautics (a book written in 1784).—Gliding Flight.—Arnold Samuelson (with photo. of model aeroplane).—Finding the Position of Sounding Balloons: W. de Fonvielle.—The Influence of Wind Pressure on the Rope of Captive Balloons.—Induction and Deduction in Aeronautics.—Official Account of the U.S. War Ballooning in Cuba (in English).—Buttenstedt and the Flying Problem.—Scientific Kite Flying in America: Warren H. Smith (in English).—Notes.—Myer's Sky Cycle, &c.—Proceedings of Societies—Patents.

Notable Articles.

June. *Cosmopolitan.*—"Progress in Air Ships." Illustrated description of Danilevski's and Santos-Dumont's.

July 10. *Daily Mail.*—"A Runaway Balloon." Ascent at Bradford.

10. *Bradford Observer.*—"Exciting Balloon Voyage."

14. *English Mechanic.*—"Flying Craft made Perfect." Prof. Langley's Machine (?) (*vide* "Notes").

14. *The Church Family Newspaper.*—"Up in a Balloon." Interview with Messrs. Spencer.

15. *Speaker.*—"The Possibilities of Flight."

15. *Field.*—"Long Distance Ballooning." Reprinted in this Journal (*vide* p. 78).

27. *Daily News.*—"Mr. Maskelyne's Wireless Telegraphy," in Conjunction with Mr. Bacon's Balloon Ascent.

29. *Daily News Weekly.*—"Prof. Langley's Aerodrome." Fully but incorrectly described.

31. *Daily News.*—"Balloon Voyage Across the Channel." Personal narrative by Mr. Spencer.

Aug. *Strand Magazine.*—"Over the Alps in a Balloon." (Illustrated.)

4. *Militar Zeitung* (Vienna).—"Military Ballooning."

13. *Manchester Umpire.*—"Ships of the Air—In a Balloon Factory." An interesting account of Messrs. Spencer's establishment.

21. *Daily Telegraph.*—"Up in a Balloon." Account of an ascent from the Crystal Palace.

Sept. 2. *Invention.*—"Balloons." G. TOFTS.

2. *Daily News Weekly.*—"A Balloonist's Adventures." Relates to M. Gaudron.

16. *Revue Scientifique.*—"Physique du Globe." Contains many interesting facts concerning the upper atmosphere gained by recent balloon and kite experiments.

16. *Illustrated Sporting and Dramatic News.*—"Ballooning." General account.

27. *Sketch.*—"Balloon Photography." Illustrated with four good birdseye pictures.

During the three months the *English Mechanic* has published a running correspondence on "Flying Craft," &c. Though a great deal has been written, there is little that is new, or of special interest in the correspondence.

Applications for Patents.

(*July, August, September*, 1899.)

14,615. July 15. HEINRICH BAUER, London. **Improvements in or Relating to Balloons or Aerial Machines.** (*Complete.*)

14,802. July 18. GUSTAV LOEPER, London. **Improvements in Navigable Balloons.** (*Complete.*)

14,958. July 20. ROBERT J. STANLEY, Cardiff. **An Improved Mode of Aerial Navigation for Torpedoes and other Machines.**

15,673. August 1. G. V. DUSINA, Rome. **A Navigable Air Ship.**

15,811. August 2. L. W. BROADWELL, Clapham. **Improvements in Flying Machines.**

15,877. August 3. EDWARD FENN JONES, Blackheath. **Screw Propeller for Regulating the Ascent and Descent of Balloons.**

16,840. August 19. H. W. C. COX and C. F. LEIGHTON, London. **An Apparatus for Im-**

provements in Steering and Guiding Boats, Torpedoes, Balloons, and other Floating Vessels.

17,611. August 31. BURTON BROWN, Burnley. Improvements in Appliances for Affecting Aerial Navigation.

17,760. September 2. THOMAS MOY, London. Improvements in or Relating to the Propulsion of Aerial Vessels.

17,913. September 5. ANATASIA BAUMANN Liverpool. Water and Air Ship. (*Complete.*)

17,977. September 6. W. G. WALKER, London. Improvements in Aerial Screw Steamers or Flying Machines.

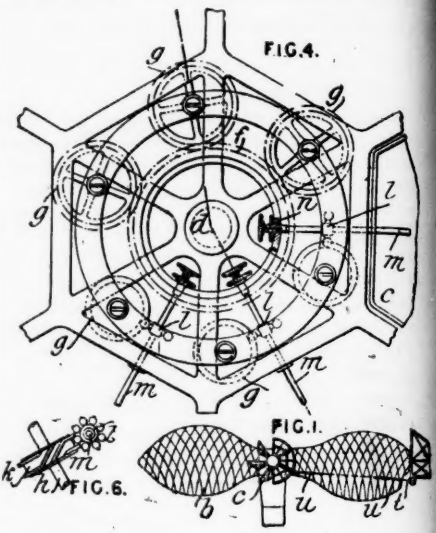
Patents Published.

Nos. 304, 557, 2,986, 3,515, 3,922, 4,257, 4,258, 4,842, 5,499, 7,214, 9,295, 9,875, are abandoned.

10,162. Balloons as Lifts or Elevators in Tall Towers.

11,914. May 25. Navigable Balloons. ZARSKI, E., 68, Boulevard de la Liberté, Lille, Nord, France.

The machine is propelled by feathering paddles *c* revolving on a shaft on a level with the axis of the aerostat *b*. The vanes *c* are carried on shafts *m*, and are turned through a quarter of a revolution each time they come into and go out of action by cams *k*, Fig. 6, on shafts *h* which engage wheels *l* on the shafts *m*. The wheels *l* have spherical bowls on their teeth, and the shafts *h* carry wheels which gear with a fixed wheel *f* of double their diameter, so that they make two revolutions about their axes to one of the shaft *d*. The end thrust of the shafts *m* is taken on ball bearings or pivots *n*. The steering-ropes *t* connected with the rudder *p* pass through the balloon and have conical



collapsable sleeves *u* attached to them at one end and to the balloon at the other, to prevent leakage. The axis of the paddles may be turned relatively to the axis of the balloon to steer the machine.

United States Patents.

Nil.

French Patents.

285,756. GENTIL. Aerostat Dirigeable.

286,389. PRAT. Nouveau Balloon Dirigeable.

286,541. March 6. DE LA TOUCHE. Ballons Jumeaux Captifs Economiques et Sans Danger.